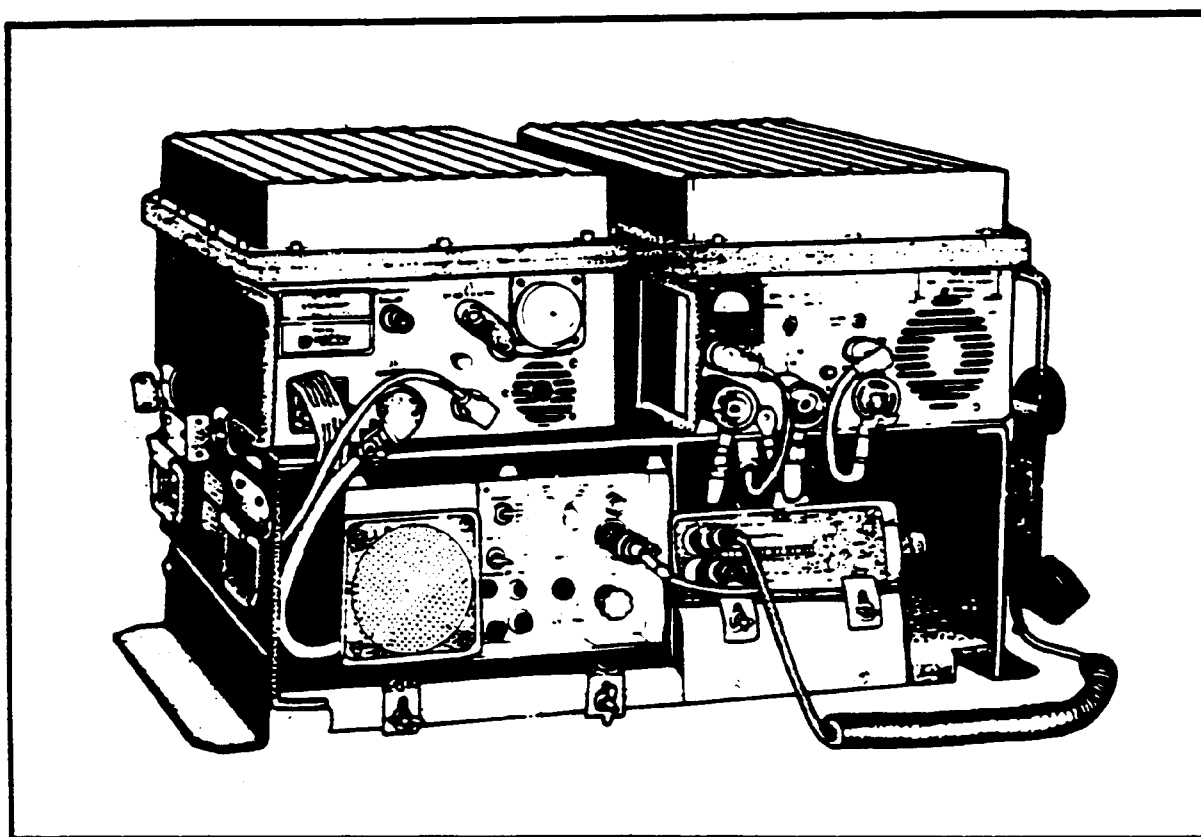


SUBCOURSE
SS0711

EDITION
A

US ARMY FIELD ARTILLERY SCHOOL

INSTALL AND PERFORM
UNIT-LEVEL MAINTENANCE OF
AN/GRC-193A RADIO SET
(IHF), PART II



THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT
ARMY CORRESPONDENCE COURSE PROGRAM

A
I
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READINESS/
PROFESSIONALISM



THRU
GROWTH

UNIT LEVEL COMMUNICATIONS MAINTAINER
MOS 31V SKILL LEVELS 1 and 2

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744-2425 , Revised September : 1987

INSTALL AND PERFORM UNIT-LEVEL MAINTENANCE
OF AN/GRC-193A RADIO SET (IHFR), PART II

SUBCOURSE SS0711

US Army Signal School
Fort Gordon, Georgia

Six Credit Hours

GENERAL

This subcourse is designed by the US Army Field Artillery School to train the skills necessary for performing tasks related to maintenance of improved high-frequency radio (IHFR) AN/GRC-193A. This subcourse is presented in four lessons, each lesson corresponding to a terminal objective supporting the following soldier's manual tasks:

LESSON 1: Install or Reinstall AN/GRC-193A Radio Set (IHFR)

TASK NO: 113-620-1025

TASK: Install radio set AN/GRC-193(*) in a tactical vehicle.

CONDITIONS: This task is performed upon receipt of a new vehicle, on the return of a vehicle from support maintenance, or as directed by your supervisor. You will be provided with the following:

1. Installation kit.
2. Radio set AN/GRC-193.
3. Tactical vehicle.
4. Tool kit TK-101/G.
5. Multimeter AN/PSM-45.
6. Shop equipment, auto common No. 1.
7. Appropriate 2300-series TM.
8. TM 11-5820-924-13.

9. GTA 11-3-51.
10. DA Pam 738-750.
11. DA Form 2404.

STANDARDS: The system has been installed, a system check has been made, completed DA Form 2404 and submitted to your supervisor without error.

LESSON 2: Evaluate Operation of AN/GRC-193A Radio Set

TASK NO: 113-620-2025

TASK: Evaluate the operation of radio set AN/GRC-193(*).

CONDITIONS: This task is performed when an operator reports an uncorrected fault, as a part of PMCS, as directed by your supervisor, to identify a fault before troubleshooting, or as a final check after repairs. You will be provided with the following:

1. Radio set AN/GRC-193(*) installed.
2. GTA 11-3-51.
3. Operational compatible radio set with operator.
4. TM 11-5820-924-13.
5. Appropriate 2300-series TM.
6. DA Pam 738-750.
7. DA Form 2404.

STANDARDS: Determine the operational readiness of the system and report the status to your supervisor without error.

LESSON 3: System Troubleshoot AN/GRC-193A Radio Set, and Repair

TASK NO: 113-620-0052

TASK: System troubleshoot radio set AN/GRC-193(*).

CONDITIONS: This task is performed when an operator reports an equipment malfunction or as directed by your supervisor. You will be provided with the following:

1. Radio set AN/GRC-193(*) installed.

2. Distance operational compatible radio set with operator.
3. Tool kit TK-101/G.
4. Multimeter AN/PSM-45.
5. Dummy load.
6. Test set AN/USM-298.
7. Spare components.
8. TM 11-5820-924-13.
9. GTA 11-3-51.
10. DA Pam 738-750.
11. DA Form 2404 (completed by operator).
12. DA Form 2407.

STANDARDS: Using troubleshooting methods, identify the defective item or items of equipment and take corrective action without error.

LESSON 4: Perform Organizational Preventive Maintenance Checks and Services on AN/GRC-193A

TASK NO: 113-620-3049

TASK: Perform organizational preventive maintenance checks and services on AN/GRC-193A radio set.

CONDITIONS: This task is performed in a tactical or nontactical situation, under all weather conditions, and may be performed in an NBC environment. This task is performed when scheduled on DD Form 314 or at the direction of your supervisor. You will be provided with the following:

1. An appropriate tactical vehicle or communications shelter with AN/GRC-193A radio set installed.
2. Cleaning cloth and fine sandpaper.
3. Cleaning compound (trichlorotrifluoroethane).
4. Masking tape.
5. Paint primer.

6. Epoxy paint.
7. Enamel paint.
8. GP liquid detergent.
9. Paintbrush.
10. Tool kit TK-101/G.
11. Multimeter AN/PSM-45.
12. TM 11-5820-924-13.
13. DA Form 2404.

STANDARDS: This task has been performed correctly when performance measures 1 through 7 have been completed.

1. Perform PMCS in accordance with TM 11-5820-924-13.
2. Complete DA Form 2404 in accordance with DA Pam 738-750.
3. Turn in DA Form 2404 to supervisor with any uncorrected faults noted.

TABLE OF CONTENTS

Section	Page
TITLE PAGE.....	i
TABLE OF CONTENTS.....	v
Lesson 1: Install or Reinstall AN/GRC-193A	
Introduction.....	1
Radio Configuration.....	1
Installation Kit Instructions For MK-2459/GRC-193A, General-Purpose Installations.....	9
Installation or Reinstallation.....	11
Safety.....	12
Summary.....	14
Lesson 2: Evaluate Operation of AN/GRC-193A Radio Set	
Introduction.....	15
Controls, Indicators, and Connections	15
Equipment Performance Check (EPC) or OP Check With EPC.....	19
Abnormal Indications.....	22
Audio Indicators.....	22
Procedures for Operation.....	22
Summary.....	24
Lesson 3: System Troubleshoot AN/GRC-193A Radio Set, and Repair	
Introduction.....	25
Major Component Direct Exchange.....	25
Replaceable and Repairable Items.....	25
Power Control.....	27

AM-6879 Functions.....	28
Indicators for Troubleshooting.....	28
Tuning.....	28
Transmit.....	28
Summary.....	30
Lesson 4: Perform Preventive Maintenance Checks and Services on AN/GRC- 193A	
Introduction.....	31
Organization-Level PMCS.....	31
Summary.....	35

Lesson 1 INSTALL OR REINSTALL IHRF RADIO SET AN/GRC-193A

OBJECTIVE

Upon completion of this lesson, you will be able to install or reinstall the AN/GRC-193A radio set in an MT-6232 rack mounted in an S-280A shelter.

REFERENCES

This subcourse is based on TM 11-5820-924-13, TM 11-2300-475-13&P-2, and other materials approved for US Army instruction. However, development and progress render the text continually subject to change. Therefore, base your examination answers on material presented in this subcourse rather than on individual or unit experience.

1. INTRODUCTION. As maintenance personnel, your job is to ensure that radio sets are operating at their full potential. In other words, your job is to make sure that the radio set operates as it should, when it must, and as the mission dictates.

2. RADIO CONFIGURATION. There are three primary configurations or variations that you may encounter.

a. The configuration that is likely to be most common is mounted on MT-6232/GRC-193 with the CU-2064 facing forward. (See Figure 1.) The other configuration using the MT-6232/GRC-193 has the CU-2064 mounted in reverse for convenience in routing the radio frequency (RF) cable to the antenna. (See Figure 2.)

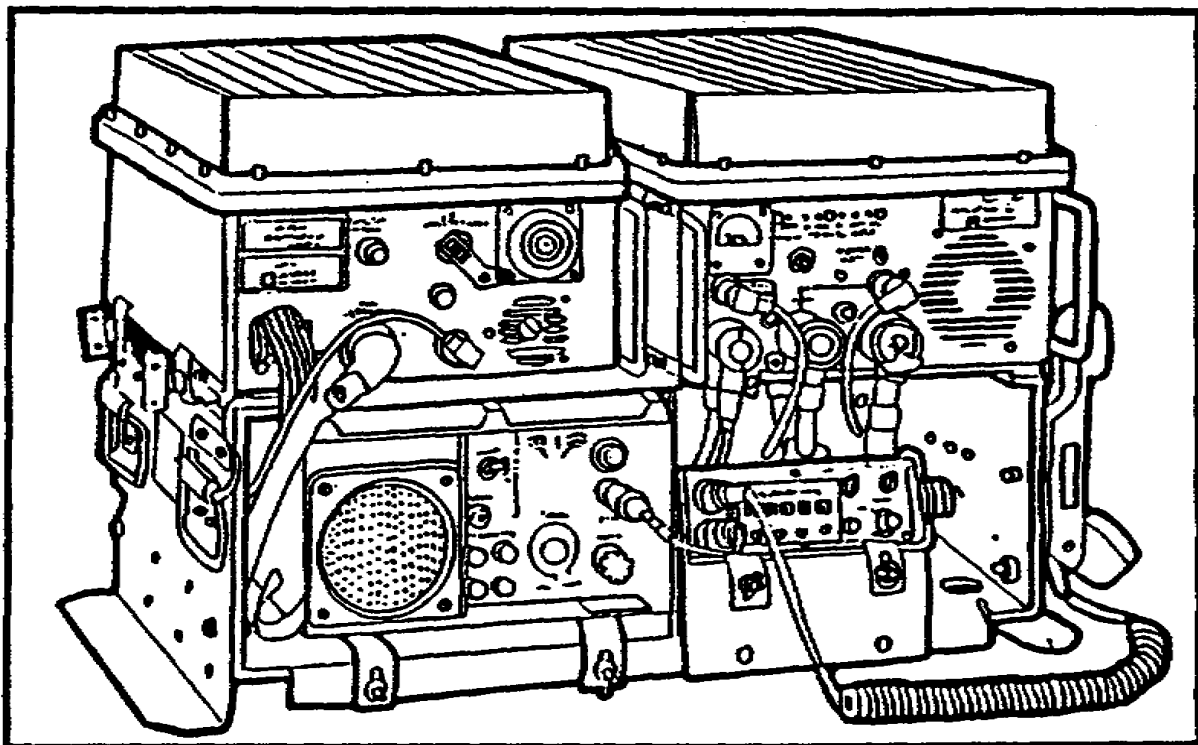


Figure 1. AN/GRC-193A (front view).

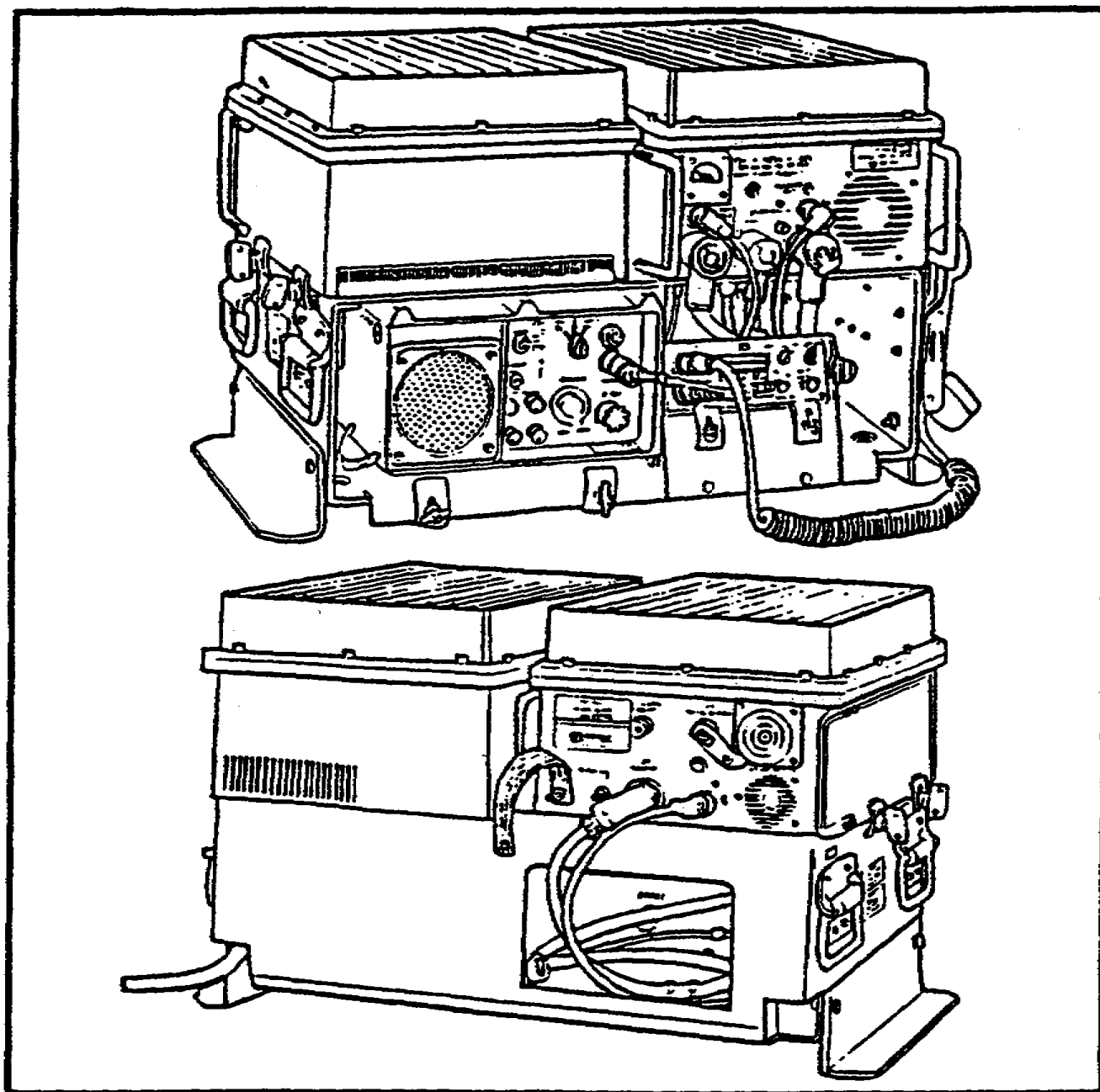


Figure 2. Reverse mounting of CU-2064.

b. The configuration for use in tracked vehicles uses MT-6233/GRC-193A, which mounts low, on line, and with the CU-2064 facing forward (see Figure 3).

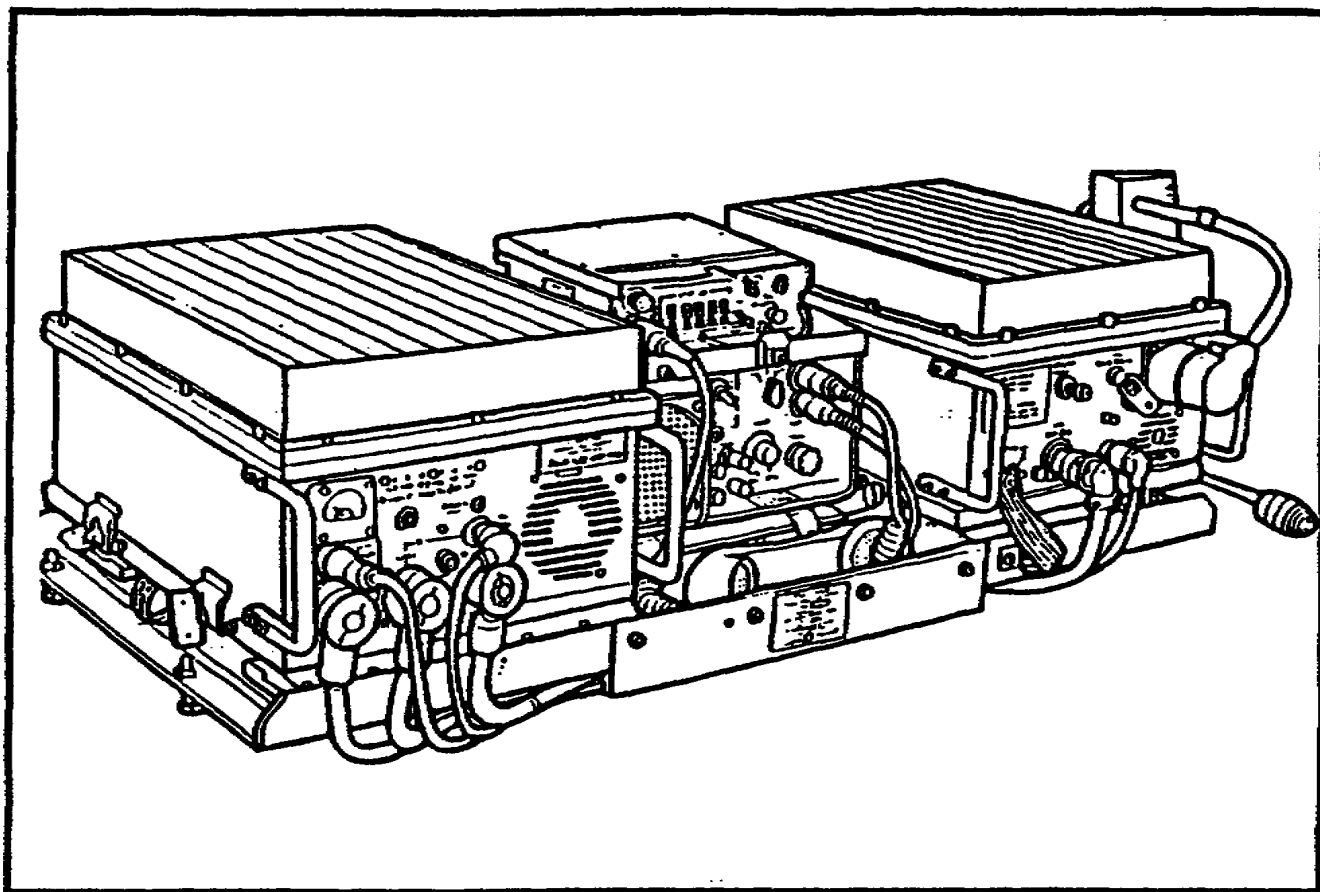


Figure 3. Configuration for tracked vehicle mount.

c. The material for this lesson is based on the MK-2459/GRC-193A installation kit which uses the MT-6232/GRC-193A.

d. In addition to the installation kit, the AN/GRC-193A is made up of four major components (shipped separately), three audio accessories, and eight cables. The components are the RT-1209/URC receiver-transmitter (RT), the AM-6879/URC amplifier converter, AM-6545 amplifier, and the CU-2064 antenna coupler. The audio accessories include the handset H-250, continuous wave (CW) key KY-872, and headset H-140. The RF output cable, battery cable CX-4720, and the RF interconnect and control cables are part of the installation kit. Remote antenna kit MT-6378/GRC-193A with antennas AT-1011, AS-2259, and AN/GRA-50 are also included in the installation kit. The PP-7333 power supply is furnished to operate the radio when mounted in the S-280A communications shelter.

e. The RT-1209/URC is the receiver-exciter in the AN/GRC-193A. It is used in AN/PRC-104A as well as AN/GRC-213 IHFR radio sets (Figure 4). The RT-1209/URC is a lightweight, compact RT. It provides 250 milliwatts (mW) of RF from 2 megahertz (MHz) to 29.9999 MHz in 100-hertz (Hz) steps providing 280,000 distinct frequencies. It is a single sideband RT with selectable upper or lower sideband. It has a MODE switch providing voice receive, voice receive and transmit, data receive, and data receive and transmit. It also has a VOLUME control labeled OFF/MAX, a push-button switch labeled LIGHT that turns on a lamp inside the frequency windows, and six one-way push-button switches for setting frequency. The frequency switches are one way only. Once the number you want passes the window, you must continue pressing the switch until the proper number rotates back into the window from 00.0000 MHz to 29.9999 MHz in 100-Hz steps. There are two audio jacks on the face of the RT and an A1J1 interface multipin connector on the side, which connects to the AM-6879.

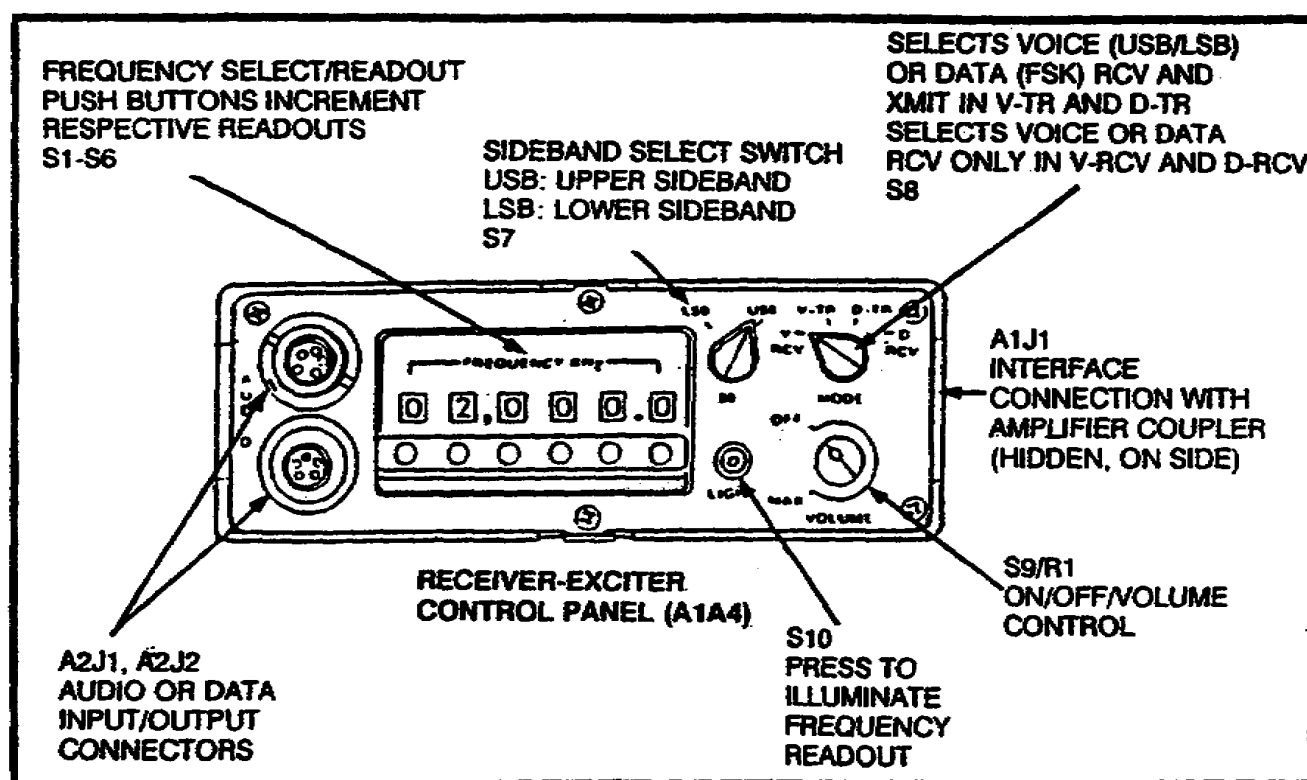


Figure 4. RT-1209/URC receiver-transmitter.

f. The AM-6879 amplifier-converter has three switches--S1 is the speaker TTY switch, S2/R1 is the squelch control switch, and S3 is the TTY loop current switch (Figure 5). TP1 and TP2 are test points to adjust loop current with the R2. E1 and E2 are TTY key connections, and E3 and E4 are TTY loop connections. LS1 is a built-in loudspeaker, and F1 is a 3-amp fuse that has a spare in the unused fuse holder in the back. It has a J1 audio jack and a J2 audio jack, which is a six-pin jack to accept security equipment input.

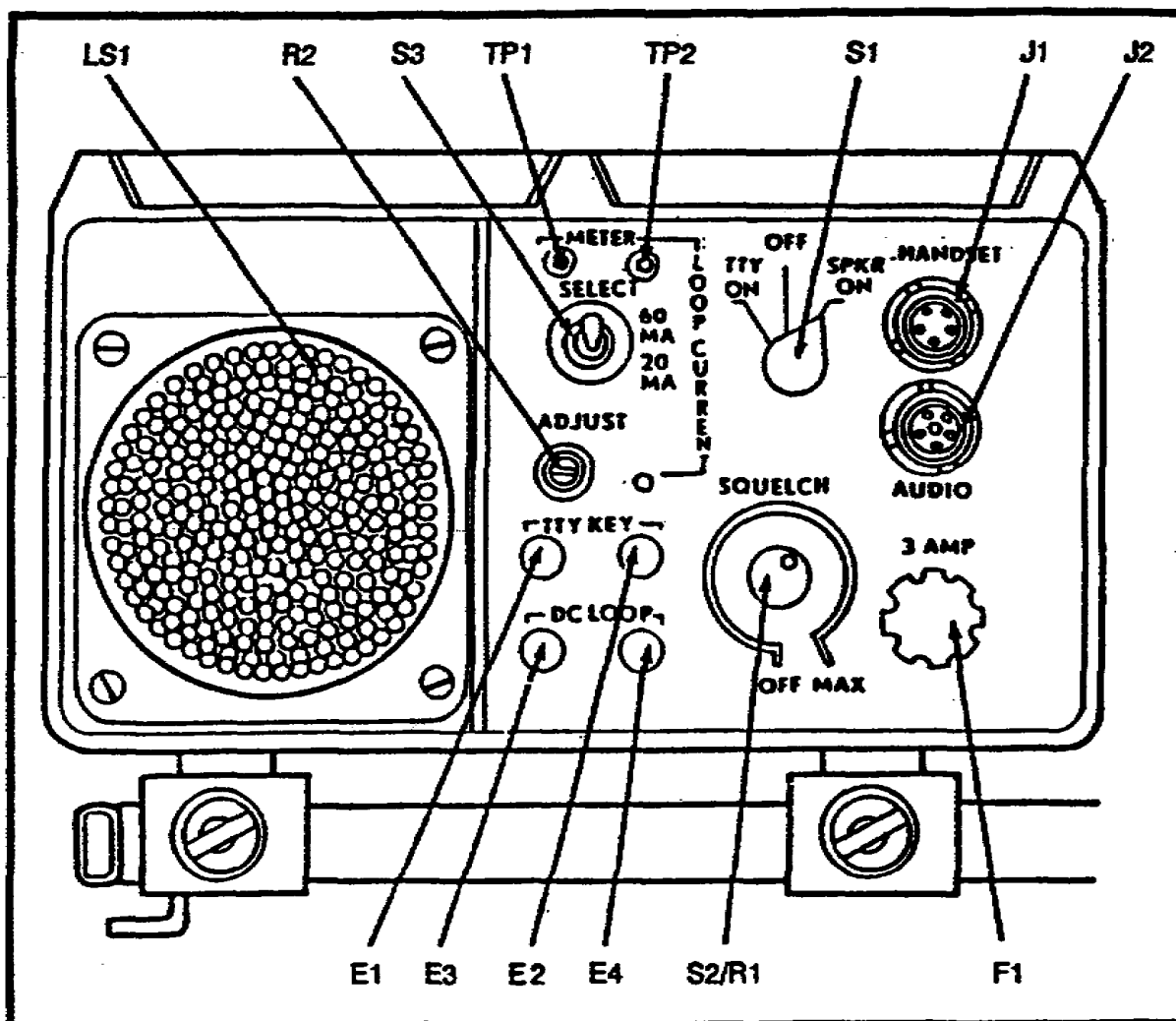


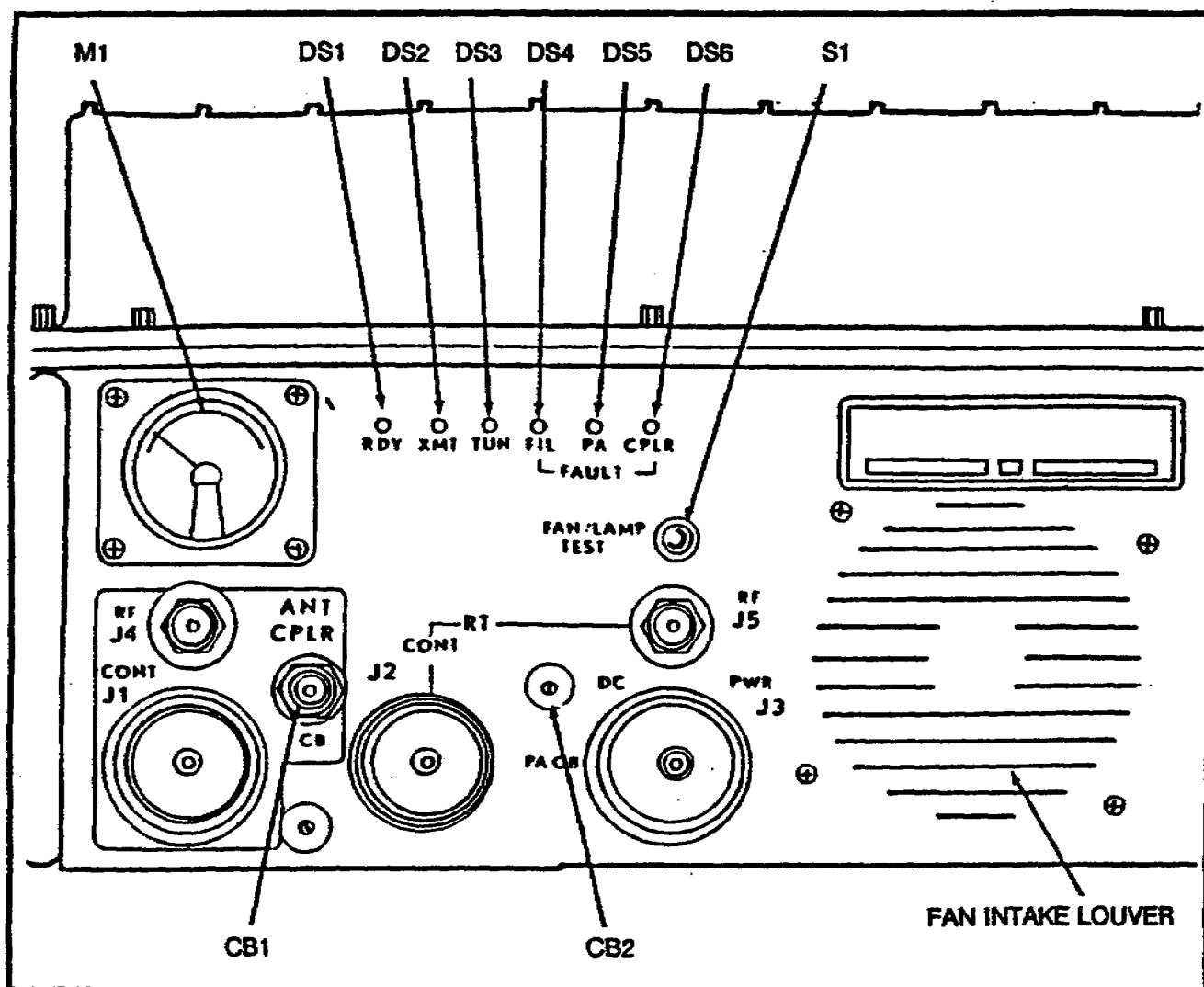
Figure 5. AM-6879 amplifier-converter.



HIGH VOLTAGE IS USED IN THE OPERATION OF THIS EQUIPMENT. DEATH ON CONTACT OR SEVERE ELECTRICAL SHOCK MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. LEARN THE AREAS OF HIGH VOLTAGE IN EACH PIECE OF EQUIPMENT. BE CAREFUL NOT TO CONTACT HIGH VOLTAGE CONNECTIONS WHEN INSTALLING OR OPERATING THIS EQUIPMENT.

g. Radio frequency amplification is furnished by the AM-6545/GRC-193 (Figure 6). The FAN/LAMP TEST switch (S1) and two circuit breakers (CB1 and CB2) are located on the front panel. The S1 switch is a push-button switch that causes the light-emitting diodes (LEDs) DS1 to DS6 to light when pressed with the RT in VTR or DTR position. Also, the S1 switch (when pressed) turns on the cooling fan. This acts as a visual indicator, as well as

an audio indicator that power is present to the power amplifier and that the indicators are all in working condition. The 100-watt (w) to 400-watt switch provides 100 w or 400 w of RF output power from the AM-6545 to the CU-2064 in transmit. There are two RF jacks (J4 and J5) on the face of the power amplifier. The J5 jack is connected to the AM-6879/URC. The J4 jack connects to the antenna coupler. The J3 jack is a DC power input cable connection from the vehicle battery or power supply. The J2 jack provides power and control connections through the AM-6879/URC to the RT-1209/URC. The J1 jack provides power and control to the antenna matching unit. The M1 is a meter used for general support (GS) troubleshooting and normally reads forward RF power.



connection is not properly grounded to the frame, the radio will not operate in a vehicle. The cooling fan is a sealed unit leading into a heat exchanger and may be cleaned with soap and water.

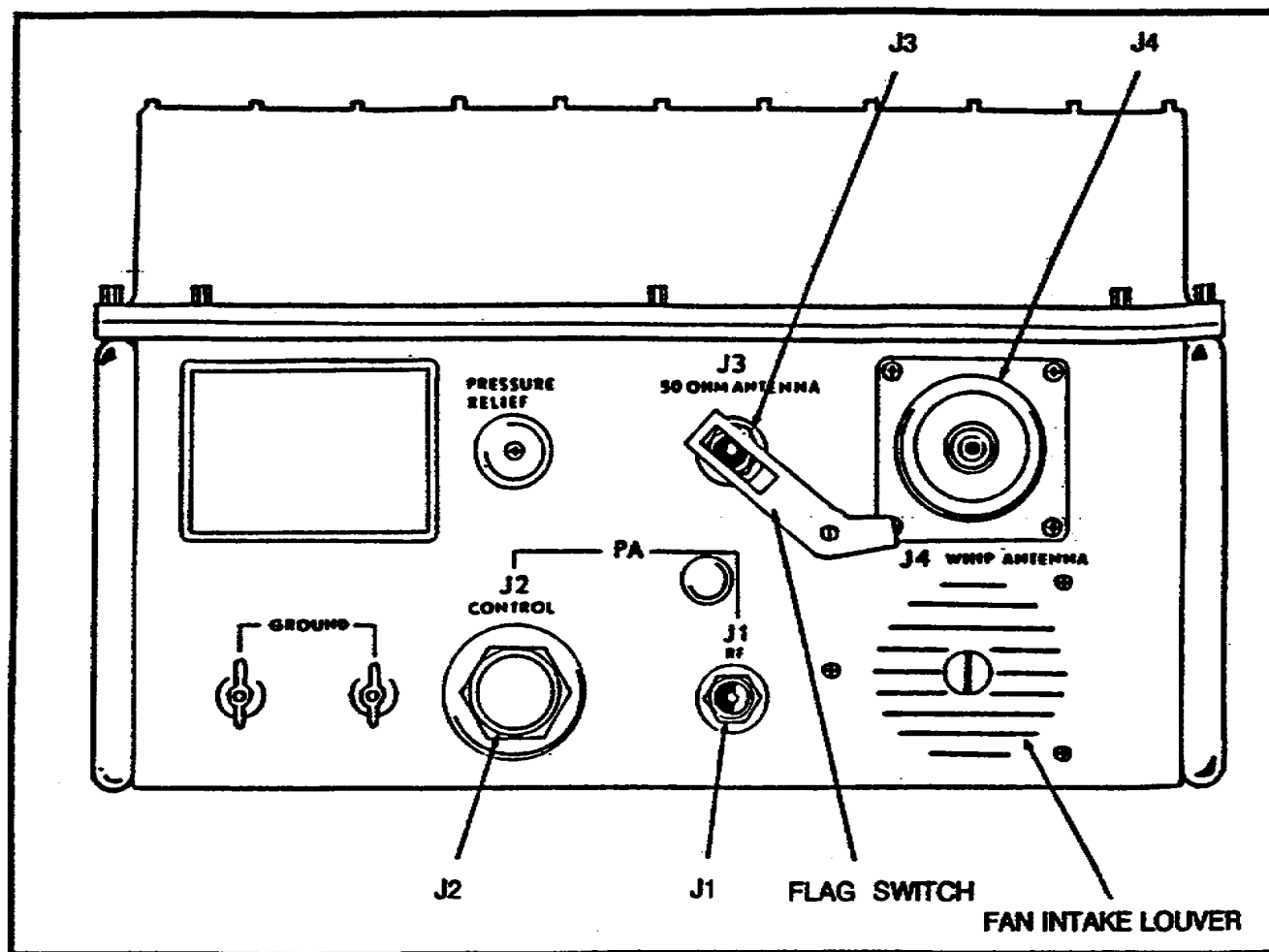


Figure 7. Antenna coupler CU-2064/GRC-193A, front panel connectors and controls.



IMPROPER GROUNDING MAY CAUSE INJURY TO PERSONNEL.

CAUTION

ALIGN COUPLER AND WHIP ANTENNA CABLE CONNECTOR BEFORE MATING AND FASTENING TO AVOID CROSS THREADING.

IF THE COUPLER IS NOT PROPERLY GROUNDED TO THE FRAME, THE RADIO WILL NOT OPERATE IN THE VEHICLE AND MAY DAMAGE EQUIPMENT.

i. The fans in AM-6545 are both sealed units that move air over heat exchangers inside the bottom plate of the unit. All connectors are located on front panels except RT-1209/URC and AM-6879/URC. The RT-1209/URC has a control connector (A1J1) on the side. The AM-6879/URC has the JS, J6, and J7 connectors on the back with a spare fuse holder. J7 is a connector for RF cable to J5 of the AM-6545. J5 of AM-6879 is the connector to control connector J2 of AM-6545, and J6 is the connector to control cable to A1J1 of RT-1209 (see Figure 8).

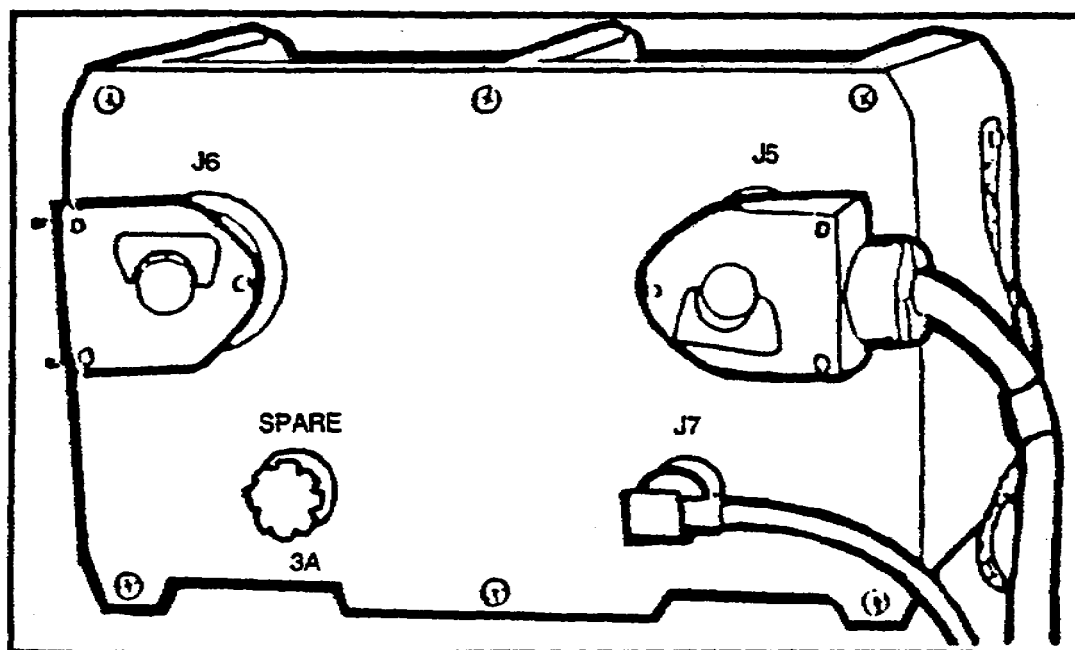


Figure 8. Rear view of AM-6879/URC.

CAUTION

BE SURE THAT COUPLER AND POWER AMPLIFIER AIR INLETS (FRONT OF UNIT) AND EXHAUST PORTS (REAR OF UNIT) ARE NOT OBSTRUCTED BEFORE OPERATING EQUIPMENT.

3. INSTALLATION KIT INSTRUCTIONS FOR MK-2459/GRC-193A, GENERAL-PURPOSE INSTALLATIONS.

a. Use the base of the MT-6232 mount to locate and mark mounting hole positions. This installation kit is for general use, and the location of the mount must be determined by the required installation rather than a location being specified.

b. Drill six 7/16-inch holes in the vehicle or shelf.

c. Place backing plates under the vehicle panel or shelf using 3/8-inch x 1 1/2-inch bolts through the mount, shelf, and backing plate. Add a flat washer, lock washer, and nut.

d. Adjust the wing-nut bars and cleats (Figure 9) on the top shelf so that the cleats and wing-nut clamps match the notches in the sides of the AM-6545 and CU-2064 for desired orientation based on the direction of the RF cable run. These are held in place by large Phillips-head screws. These cleats must be moved to change orientation, and the wing-nut clamp bars must also be moved by removing the Phillips-head, recessed screws that will be used to remount them.

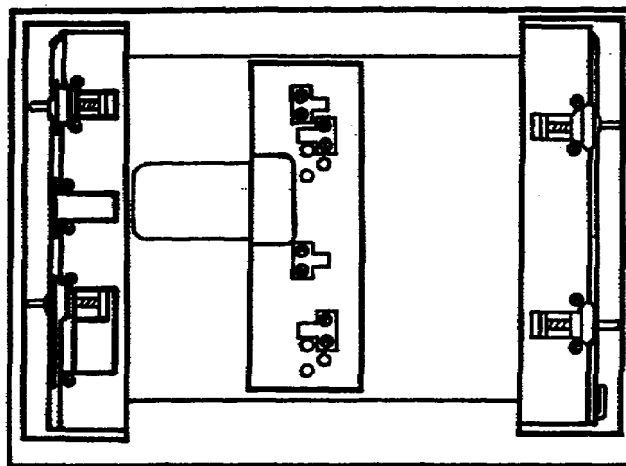


Figure 9. Cleat and wing nut clamp adjustment.

e. Cables designated W1, W2, W5, and W6 should be fed through the mount and clamped with the clamps provided in the installation kit. The clamps are screw mounted into threaded holes provided in the mount frame. Cable designated 34 should be attached to J6 of AM-6879 and lead around to the right side of the frame as the AM-6879 is slid into the mount. Cables should be mounted inside the MT-6232 when it is received, but if they are not you must mount them. (See Figure 10.)

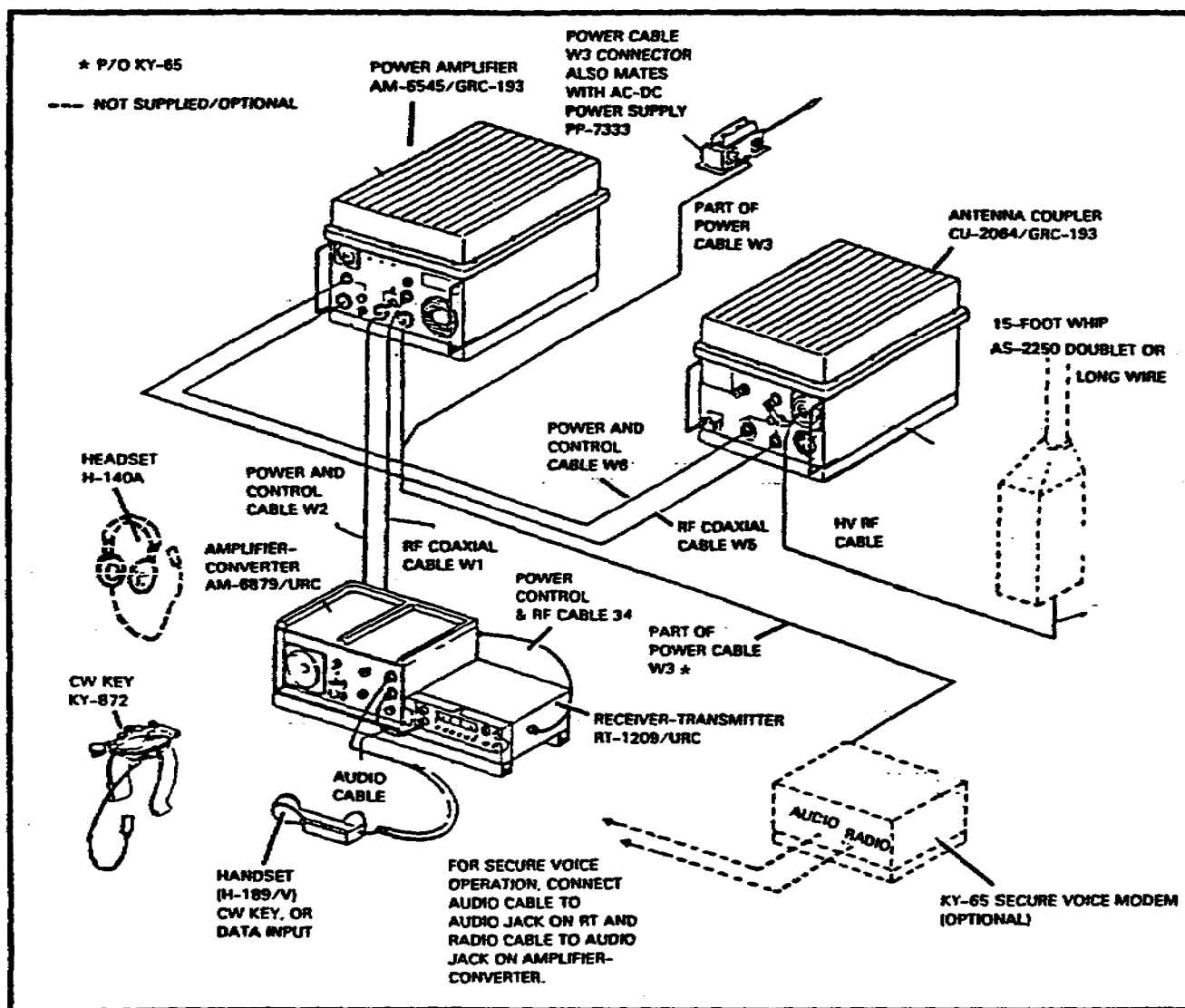


Figure 10. Cording diagram.

f. Screw down the wing-nut clamps on the front edge of the mount to clamp AM-6879 in position.

g. Seat RT-1209 in the mount, and screw down the wing-nut clamps. Plug the cable head into J1 of RT-1209, and hold it in place with the two castle-head screws provided.

h. Attach cables to J5 and J7 of AM-6879 by reaching through the back of the mount.

i. Seat AM-6545 on the top shelf, and tighten the wing-nut clamps.

j. Attach cables to J2 and J5 of AM-6545.

k. Attach CU-2064 to the shelf, and tighten the wing-nut clamps.

l. Attach cable from J1 AM-6545 to J2 CU-2064, and attach J4 of AM-6545 to J1 of CU-2064 with W5 cable.

m. Attach radio cable from J2 of AM-6879 to J2 of RT-1209.

n. Mount the antenna bracket on the vehicle.

o. Mount the antenna base and antenna.

p. Feed the antenna cable through the polyvinyl chloride (PVC) tubing (part of the installation kit), clamp it to the vehicle, and attach it to the antenna base and J4 of the CU-2064.

q. Make certain all radio switches are in the off position, and connect the power cable assembly to J3 AM-6545. Then connect the other end to the power supply junction box, red lead to positive and black lead to negative.



WHEN MAKING CONNECTIONS TO THE BATTERY TERMINALS OF A VEHICLE OR TO A POWER SUPPLY, MAKE SURE CONNECTIONS ARE TIGHT. AVOID ACCIDENTAL GROUNDING OF POSITIVE TERMINALS.

r. Route the power cable out of the way, clamp it in place with the clamps provided in the installation kit, and add the audio attachments (handset on J1 RT-1209).

s. Make sure polarity is correct. Pin B of CX-4720 at P3 should be positive.

4. INSTALLATION OR REINSTALLATION. The procedure for mounting equipment when an installation kit is already installed is the same as in d through m above. The CU-2064 must be removed from the standard mount and attached to the MT-6378/GRC-193A tactical antenna siting kit (up to 200 feet from the radio) using the RC-435/U extension cables. When used in the remote antenna configuration, the AM-6545 should be operated in the 400-watt position. The CU-2064 must be effectively grounded. If the remote cable is ran overhead, the weight of the cable must be supported to prevent damage to the cable connectors. The cable is not designed to support its own weight. Excess cable on the reel must not be stored with the flat side toward the radio but stored edge-on to the radio to prevent it acting as a big choke coil.

5. SAFETY. Safety precautions for protection of personnel and equipment are included throughout this manual wherever a procedure or condition is described that requires special care. These precautions are listed below.



HIGH VOLTAGE IS USED IN THE OPERATION OF THIS EQUIPMENT. DEATH ON CONTACT OR SEVERE ELECTRICAL SHOCK MAY RESULT IF PERSONNEL FAIL TO OBSERVE SAFETY PRECAUTIONS. LEARN THE AREAS OF HIGH VOLTAGE IN EACH PIECE OF EQUIPMENT. BE CAREFUL NOT TO CONTACT HIGH-VOLTAGE CONNECTIONS WHEN INSTALLING OR OPERATING THIS EQUIPMENT.

HIGH VOLTAGES ARE PRESENT ON THE ANTENNA DURING TRANSMISSION. DO NOT TOUCH OR STAND WITHIN 2 FEET OF THE ANTENNA WHEN THE EQUIPMENT IS ENERGIZED.

MAKE SURE POWER IS OFF BEFORE PERFORMING CLEANING AND INSPECTION PROCEDURES. ALWAYS REMOVE ALL JEWELRY BEFORE WORKING ON RADIOS.

WHEN MAKING CONNECTIONS TO THE BATTERY TERMINALS OF A VEHICLE, MAKE SURE CONNECTIONS ARE TIGHT. AVOID ACCIDENTAL GROUNDING OF POSITIVE TERMINAL.

CAUTION

AVOID OPERATING THE TRANSMITTER WITH THE ANTENNA TOUCHING ANY NATURAL OR MAN-MADE OBJECT.

BE SURE THAT COUPLER AND POWER AMPLIFIER AIR INLETS (FRONT OF UNIT) AND EXHAUST PORTS (REAR OF UNIT) ARE NOT OBSTRUCTED BEFORE OPERATING EQUIPMENT.

ALIGN COUPLER WHIP ANTENNA CABLE CONNECTOR BEFORE MATING AND FASTENING TO AVOID CROSS THREADING.

IF THE BANDSWITCH MOTOR IN THE POWER AMPLIFIER (PA) RUNS CONTINUOUSLY (AUDIBLE INDICATION) AND THE FAULT LIGHT IS ON, DO NOT ATTEMPT FURTHER TUNING OR TRANSMIT OPERATION.

6. SUMMARY. To install or reinstall the AN/GRC-193A radio, you must first verify proper mounting of the installation kit and then mount and cable the components. The components must be securely mounted to prevent personnel injury or damage to equipment. Proper cabling is required for proper operation of the system.

Lesson 2. EVALUATE OPERATION OF AN/GRC-193A RADIO SET

OBJECTIVE

Upon completion of this lesson, you will be able to verify the proper operation of an AN/GRC-193A radio set.

REFERENCES

This subcourse is based on TM 11-5820-924-13 and other material approved for US Army instruction. However, development and progress render the text continually subject to change. Therefore, base your examination answers on material presented in this lesson rather than on individual or unit experience.

7. INTRODUCTION. As an organizational maintenance person, you must be able to perform an operational check on all radios for which you are responsible to classify malfunction or determine operability of the set. You may be told to check a radio set as a routine check, or it could be because of an operator-reported problem. To aid you in this, the AN/GRC-193A has indicators built into the set to tell you about equipment condition. You must know the meaning of these indicators. For any operational check, you must verify proper installation; that is, all cabling is correct, items are correctly mounted and clamped in place, and proper connections are made for the mode of use. (See the safety summary in Lesson 1.)

8. CONTROLS, INDICATORS, AND CONNECTIONS. Tables 1 through 4 list controls, indicators, and connections for the four major components. To do an operational check in voice mode, the test frequency must be set on the RT-1209 (must be above 2 MHz). The SB switch should be set to USB. The VOLUME control should be set to the OFF position. The MODE switch is set to V-TR. On AM-6879, the TTY ON/OFF/SPKR ON switch should be set to OFF. The SQUELCH control should be OFF. On AM-6545, CB1 and CB2 must be pushed in (the buttons, protected by a plastic boot, pop out on overload and must be reset). Make certain that the correct antenna, as determined by frequency, direction, time of day, distance, etc., is connected to CU-2064. If the site you must contact is on the other side of the mountain, use near-vertical incidence sky wave(NVIS). Turn the VOLUME control switch to a midrange position. Press the FAN/LAMP TEST button on the face of AM-6545, see that the six LEDs across the face of the AM-6545 light, and listen for the fans to run. Allow the system to warm up for about 90 seconds. The amber TUN lamp comes on in the AM-6545, and a beeping 1-kHz tone is heard in the handset during warm-up. When the set has warmed to operational condition, the green RDY lamp lights and the beeping tone stops. Listen to the test station, turn the SPEAKER switch on, adjust the VOLUME OFF/MAX for a comfortable listening level, and then adjust the SQUELCH control on AM-6879. Momentarily depress the PTT switch on the handset. The green XMT lamp and yellow TUN lamp will light, and a 1-kHz tone will be heard for less than 20 seconds. When the green RDY lamp lights, tuning is complete. Contact your test station, and ensure two-way communications. Change the SB switch to LSB, and ensure two-way communications. Sidetone will be heard in the transmit position, and the M1 meter deflects to the right when you whistle or talk into the microphone. The speaker should be silenced in the transmit position. If the yellow FIL lamp lights, it indicates low RF power out and requires that the AM-6545 be

sent to higher maintenance. If the PA or CPLR lamps come on, momentarily turn the MODE switch to V-RCV, then return to the V-TR position and retune, and then try again to transmit. If the lamps persist in remaining lit, either the AM-6545 or the CU-2064 must be referred to higher maintenance. (See Tables 2 through 4.)

Table 1. Controls, indicators, and connectors for RT-1209/URC.

ITEM	FUNCTION
FREQUENCY KHZ push buttons and display	Select and display operating frequency. System automatically tunes (when push-to-talk [PTT] switch on handset is operated) to selected frequency for all changes except 100 Hz (farthest right push button). Each push button changes the digit displayed directly above it by adding 1 to the displayed number. There are 280,000 frequencies available between 2,000.0 and 29,999.9 kilohertz (kHz).
SB switch	The SB switch selects upper sideband (USB) or lower sideband (LSB). Either position can be used for voice and data signals. Modulation must be the same as that used by communicating radio.
VOLUME OFF/MAX control	The OFF position removes operating power from the system. Clockwise rotation switches on the power and increases the volume in the handset earpiece connected to the AUDIO jack and to the speaker in the amplifier-converter when in the VOICE mode.
MODE switch	Selects one of four operating modes. They are: <ul style="list-style-type: none"> ● V-RCV (voice-receive)--for receiving voice, CW, or teleprinter signals. Inhibits power. ● V-TR (voice-transmit/receive)--for transmitting and receiving voice, CW, or teletypewriter signals. ● D-TR (data-transmit/receive)--for transmitting and receiving data signals. ● D-RCV (data-receive)--for receiving data signals only. Inhibits power distribution to amplifier and coupler.
LIGHT switch	Lights FREQUENCY KHZ display when pressed.
AUDIO connector (upper)	For connection of handset for voice operation, CW key/handset, or data input.
AUDIO connector (lower)	For connection of audio cable to amplifier-converter.
J1 (side of unit)	For connection of power, control, and RF cable to amplifier-converter.
PTT switch (on handset connected to AUDIO jack).	Initiates automatic fine tuning to selected frequency and keys transmitter for voice operation.

Table 2. Amplifiers-converter AM-6879/URC controls and indicators.

ITEM	FUNCTION
TTY ON/OFF/SPKR ON selector	Selects voice (SPKR ON) or digital (TTY ON) function of amplifier-converter. If SPKR ON is selected, received voice signals are amplified and applied to speaker. If TTY ON is selected, a teletypewriter connected at DC LOOP terminals (for transmit and receive operation) or a TTY KEY terminal (for transmit only) will be interfaced with the RT for radio teletype operation through an internal TTY converter.
SQUELCH OFF/MAX control	Controls suppression of received audio when no useful voice signal is present. The OFF position disables the circuit; rotating the control clockwise increases the level at which signals and noise are squelched. Desired setting reduces or eliminates background noise between useful audio signal receptions but does not make useful signals inaudible.
LOOP CURRENT control selects 60 ma or 20 ma	Selects 60 milliamperes (ma) or 20 ma loop current drive for the teletypewriter connected to the DC LOOP terminals. Set as required by device connected.
METER jacks	Connect external meter to read TTY loop current.
ADJUST potentiometer	Adjust TTY loop current to 20 ma or 60 ma, as read on external meter.
3 amp fuse	Fuses circuits in amplifier-converter. The fuse can be replaced by removing the cap.
TTY KEY terminals	Connect teletypewriter for transmit only operation.
DC LOOP terminals	Connect teletypewriter for receive and transmit operation.
HANDSET jack	Connects handset for voice operation or telegraph key for CW operation.
AUDIO jack	Connects audio cable to receiver-transmitter (except secure voice operation).
Loudspeaker	Outputs received audio signals.
Jack J5 (rear of unit)	Connects control and power cable to power amplifier.
Jack J6 (rear of unit)	Connects signal, control, and power cable to RT.
Jack J7 (rear of unit)	Connects RF signal cable to power amplifier.

Table 3. Power amplifier AM-6545/GRC-193 controls and indicators.

ITEM	FUNCTION
FAN/LAMP TEST push button	Press to test indicator lamps on front panel of power amplifier and fans in power amplifier and coupler. (System must be turned on at RT and MODE switch on RT must be in V-TR or DTR.)
RF POWER OUT switch	100W-400W toggle switch controls RF output power.
ANT CPLR CB	Circuit breaker for +26.5 v DC (nominal) power distributed to coupler. Press to reset.
PA CB	Circuit breaker for +26.5 v DC (nominal) power distributed in power amplifier and fans in the coupler. Press to reset.
Meter	Displays power output of power amplifier. (Can be internally switched to meter test voltages within power amplifier.)
FAULT lamps	
FIL (yellow)	When illuminated, indicates faulty filament of an amplifier tube.
PA (red)	When illuminated, indicates power amplifier fault.
CPLR (red)	When illuminated, indicates coupler fault.
TUN lamp (yellow)	PA warming up--ON PA warmed up, in TUNE mode--ON System tuning--ON System tuned (ready to RX-TX)--OFF During transmission (PTT pressed)--OFF
RDY lamp (green)	PA warming up--OFF PA warmed up, in TUNE mode--ON System tuning--ON System tuned (ready to RX-TX)--ON During transmission (PTT pressed)--ON
XMT lamp (green)	PA warmed up--OFF ¹ PA warmed up, in TUNE mode--OFF System tuning--ON System tuned (ready to RX-TX)--OFF During transmission (PTT pressed)--ON
1XMIT	Inhibited during warm-up--radio cannot be keyed.
Jack J1	Connects power and control cable to coupler.
Jack J2	Connects power and control to amplifier-converter.

Table 3. Power amplifier AM-6545/GRC-193 controls and indicators (continued).

ITEM	FUNCTION
Jack J3	Connects primary power cable to circuit breaker box.
Jack J4	Connects RF cable to coupler.
Jack J5	Connects RF cable to amplifier-converter.
Pressure relief valve	Releases internal pressure in power amplifier if it exceeds 4 pounds per square inch, ambient (psia).

Table 4. Antenna coupler CU-2064/GRC-193 controls and indicators.

ITEM	FUNCTION
Antenna flag switch	Switch coupler RF input-output to whip antenna connector J4 or to 50-ohm antenna connector J3 when antenna connection is made to one of these jacks. Mechanically prevents connection to the other jack.
J1	Connects RF cable to power amplifier.
J2	Connects power and control cable to power amplifier.
J3	Connects 50-ohm antenna cable.
J4	Connects whip antenna cable.
Pressure relief valve	Releases internal pressure in coupler if it exceeds 4 psia.
Chassis ground terminals	Provide for ground connection to mounting rack.

9. EQUIPMENT PERFORMANCE CHECK (EPC) OR OP CHECK WITH EPC.

- a. Initial adjustments. Turn volume OFF/ON switch of RT-1209 to OFF.
- b. Installation.

(1) Verify proper installation of installation kit in the vehicle, in accordance with the installation kit instructions.

(2) Verify proper installation of all components, cables, and accessories.

- (3) Ensure that the set is connected to an appropriate power source.
- c. Operational (OP) check for radio set AN/GRC-193 (see Table 5).
- (1) Preset controls.
 - (2) Set TTY ON/OFF/SPKR ON switch of AM-6879 to OFF.
 - (3) Turn SQUELCH OFF/MAX switch of AM-6879 to midrange.
 - (4) Press CB1 and CB2 of AM-6545.
 - (5) Turn MODE switch RT-1209 to V-TR position.
 - (6) Turn SB switch of RT-1209 to USB.
 - (7) Push FREQUENCY KHZ switches of RT-1209 to display 05000.0 kHz.

Table 5. EPC

<u>STEP</u>	<u>FUNCTION</u>	<u>ACTION</u>	<u>NORMAL INDICATION</u>
1	Power	Turn VOLUME OFF/ON switch to midrange and press LIGHT switch on RT-1209.	FREQUENCY KHz display windows light.
2	Power	Press FAN/LAMP TEST switch momentarily.	Six lamps on AM-6545 light (FAULT, FIL, PA, CPLR, TUN, RDY, XMT).

NOTE: You will hear a beeping sound from the handset for approximately the first 90 seconds after the radio set is turned on. Allow 90 seconds for warmup or until beeping stops and green ready lamp lights.

3	Receive	Set TTY ON/OFF/SPKR ON switch to SPKR ON.	Hear receive noise from speaker and in handset.
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CAUTION

IF BANDSWITCH MOTOR IN PA RUNS CONTINUOUSLY (AUDIBLE INDICATION) AND THE FAULT LIGHT IS ON, DO NOT ATTEMPT/TRY FURTHER TUNING OR TRANSMIT OPERATION.

Table 5. EPC (continued).

<u>STEP</u>	<u>FUNCTION</u>	<u>ACTION</u>	<u>NORMAL INDICATION</u>
NOTE: The National Bureau of Standards provides time signals on multiples of 5 MHz over WWV/WWVA in the continental United States (CONUS). Outside CONUS, change frequency to that of any AM station broadcasting between 2 MHz and 29.9999 MHz. Listen to the station on your radio set, the signal should be loud and clear.			
4	Squelch control	Tune off frequency and turn SQUELCH control clockwise until receiver noise is quieted.	Receiver noise is eliminated.
5	Volume	Turn VOLUME ON/OFF switch to a comfortable listening level. Change frequency switches back to previous setting.	Controls volume of received signal.
6	Sideband	Turn SB switch to LSB, and listen to signal.	Signal should remain clear.

NOTE: Turn SB switch to position authorized by net control station (NCS).



DANGEROUS VOLTAGES ARE PRESENT ON THE ANTENNA AND ON THE COUPLER ANTENNA CABLE WHILE THE TRANSMITTER IS OPERATING. DO NOT STAND WITHIN 2 FEET OF THE ANTENNA OR ALLOW ANYTHING TO TOUCH THE ANTENNA WHILE TRANSMITTING.

7	Keying	Set FREQUENCY KHz switches to NCS frequency, and momentarily press PTT switch.	TUN, RDY, XMT lamps lit and 1-kHz tone heard for less than 20 seconds. TUN and XMT lamps go off with 1-kHz tone and RDY lamp remains lit.
8	Transmit and signal	Press PTT switch, hold and speak into handset.	RDY lamp goes out. XMT lamp is lit. M1 meter deflects with each sound or sidetone heard.

Table 5. Op check (continued).

<u>STEP</u>	<u>FUNCTION</u>	<u>ACTION</u>	<u>NORMAL INDICATION</u>
9	RT transmit	Press PTT. Speak to NCS or another distant station.	Establish communication with a distant station.
10	Listening silence	Turn MODE switch to V/RCV.	Lamps and blowers on CU-2064 and AM-6545 go off. Receiver operates.
11	Shutdown	Turn VOLUME OFF/ON control fully counterclockwise	Removes power.

10. ABNORMAL INDICATIONS. Any abnormal indications must be entered on DA Form 2404 (Equipment Inspection and Maintenance Worksheet). Abnormal indications show a need for systems troubleshooting to determine which cable or accessory requires replacement or repair or which component requires evacuation to higher maintenance.

11. AUDIO INDICATORS. Audio indicators are provided by the RT-1209. They indicate a low-voltage condition (a clicking sound, particularly in the receive mode), a tuning fault (a beeping 1-kHz tone), fine tuning (a steady 1-kHz tone), and a disturbance of antenna condition during transmit (a single 1-kHz beep). Transmit Is locked out during any tuning sequence, but you must know what these audible tones mean and when to expect them. A tune fault tone is heard from turn-on until warm-up is achieved.

12. PROCEDURES FOR OPERATION.

a. Voice or CW key connections. If voice or CW key operation is to be used, make the connections. For voice operation, connect the handset to the HANDSET jack on the amplifier-converter or to the upper AUDIO jack on the RT. (Press connector inward and twist clockwise.) The short audio cable is connected between the AUDIO jack on the amplifier-converter and the lower AUDIO jack on the RT. For CW key operation, connect the CW key to the AUDIO jack on the amplifier-converter. Connect the headset to the AUDIO jack on the RT.

b. Data operation. For operations involving data transmission, connect the data input to either the AUDIO jack on the amplifier-converter or to the upper AUDIO jack on the RT.

c. Secure voice operation. For secure voice operation with the KY-65 secure voice modem, disconnect the short audio cable from the lower AUDIO jack on the amplifier-converter (push connector inward, and turn counterclockwise). Connect the KY-65 secure voice audio cable between the AUDIO jack on the secure voice modem and the AUDIO jack on the RT. Connect the handset to the HANDSET connector on the amplifier-converter. Connect the power cable branch to the power connector on the secure voice modem. Connect the KY-65 secure voice radio cable between the lower AUDIO connector on the amplifier-converter and the RADIO connector on the secure voice modem.

d. Teletypewriter operation. The teletypewriter is connected to the terminals on the amplifier-converter. If the transmit-only operation is to be used, connect the teletypewriter wires to the terminals marked TTY KEY. If both transmit and receive operations are to be used, also make connections to the terminals marked DC LOOP as directed in the instructions for the teletypewriter. Determine the loop drive current required by the teletypewriter (either 20 ma or 60 ma). Loop both LOOP and TTY KEY, and read the ma on the external meter connected to meter terminals.

PRACTICE EXERCISES:

5. Fault indicator lamps are provided in the--
 - a. AM-6879.
 - b. RT-1209.
 - c. AM-6545.
 - d. CU-2064.
6. The switch used to turn the system on or off is located in the--
 - a. AM-6879.
 - b. RT-1209.
 - c. AM-6545.
 - d. CU-2064.
7. A lighted yellow FIL lamp indicates--
 - a. a low battery condition.
 - b. the CU-2064 is tuning to antenna.
 - c. the AM-6545 is out of alignment.
 - d. low transmit power.
8. As an operational preset, you must press CB1 and CB2 on the--
 - a. AM-6879.
 - b. RT-1209.
 - c. AM-6545.
 - d. CU-2064.

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ANSWERS:

- 5. c.
- 6. b.
- 7. d.
- 8. c.

//

13. SUMMARY. You know the equipment as a radio set and what the indicators mean. You can verify proper operation of the system or determine that an equipment defect does exist. If you determine that no defect exists, you can say with confidence that the system operates as it should.

Lesson 3 SYSTEM TROUBLESHOOT AN/GRC-193A RADIO SET, AND REPAIR

OBJECTIVE

Upon completion of this lesson, you will be able to system troubleshoot an AN/GRC-193A radio set to a defective component, cable, or accessory and fix, replace, or initiate action for repair at a higher level of maintenance.

REFERENCES

This lesson is based on TM 11-5820-924-13 and other material approved for US Army instruction. However, development and progress render the text continually subject to change. Therefore, base your examination answers on material presented in this lesson rather than on individual or unit experience.

14. INTRODUCTION. The operational check (EPC) indicates that everything works as it is intended to. To keep the AN/GRC-193A operating reliably, you must know how to troubleshoot and repair the set when it does break down. You know now that an AN/GRC-193A consists of four major components--an antenna system, two audio accessories (handset and headset), a CW key, and eight interconnect cables with a power source (vehicle battery) or (DC power supply PP-7333/GRC) used for bench mounting.

15. MAJOR COMPONENT DIRECT EXCHANGE. Once you have isolated a malfunction to a major component, you must make out DA Forms 2402 (Exchange Tag), 2404, and 2407 (Maintenance Request) and evacuate the malfunctioning component to your direct support unit for direct exchange (DX). Isolation of a fault to a particular component can be very difficult with an interconnected system of components. This is why it is necessary to be very aware of all indicators provided in the AN/GRC-193A.

16. REPLACEABLE AND REPAIRABLE ITEMS. Fuses, cables, and audio accessories can be replaced by organizational maintenance and, in some instances, repaired. A problem located in an H-189 handset can probably be repaired, as can a problem in an H-140 headset; but a problem in an H-250 handset requires replacement. Figure 11 shows interconnect cabling for the AN/GRC-193A. We notice that W1, W5, and W8 cables are coaxial RF cables and can be checked with an ohmmeter. The W6, audio, and W3 power cables can be checked easily with the ohmmeter. However, W2 and RT control cables require careful checking, because the different connectors at each end are not wired pin-for-pin (pin N at the AM-6545 of the W2 cable goes to pin T at the AM-6879 end). See Table 6, which has a list of pin assignments for W2 and RT control cables.



Table 6... Cable pin assignments.

AM-6545		AM-6879	RT-1209
PIN	W2 CABLE	PIN	PIN
A		L	35
B		M	29
C		N	12
D		P	13
E		R	14
F		S	20
H		E	40
J		K	10
K		F	4
L		U	38-39
M		A	25-26
N		T	30
P		C	33
R		J	8
S		H	44
T		D	45
U		B	32-48
V	Not Used		
		U	38-39
		V	47
		W	46

NOTE: Some wires in RT control cable have multiconnection in the RT and are found at any of the pin numbers listed. Pins U, V, and W are not directly connected through the AM-6879. Therefore, they must be checked separately. Pin V of J6 goes to the center pin of J7 and pin W of J6 goes to the shell of 7. Pin U of 6 goes to pin U of J5 through the 3-amp fuse of the AM-6879 and should read a very low ohmic value. All other connections go straight through and should read 0 ohms between the same pin number from J5 to J6. This information can be used to determine if there are opens or shorts in the interconnect cables or AM-6879, to isolate a problem to cables or AM-6879, or to eliminate them from consideration.

17. POWER CONTROL. Power is controlled through the AM-6545 power distribution by the RT. Therefore, if the checks in paragraph 16 eliminate cables and AM-6879 (remember the fuse) as the source of a power problem, cable CX-4720 has been checked for power. A power problem can be caused only by the RT or AM-6545. The only method available at this time for the organizational repair person to troubleshoot such a problem is to substitute a known good RT. If this corrects the problem, you DX the RT. If it does not correct the problem, DX the AM-6545. The AN/GRC-193 turns itself off if voltage goes too high or if it overheats. If cooling louvers clog up and cause overheating, they can be washed out with soap and water. The PA and coupler are both sealed units. This must be checked before determining that a malfunction really exists in the radio set. If the PA or CPLR lamp lights, try to clear

them by turning the MODE switch to V-RCV and then back to V-TR. The CPLR fault light indicates the problem is probably in the CU-2064. The PA fault lamp indicates the problem is probably in the AM-6545. This should be the first component replaced during troubleshooting.

18. AM-6879 FUNCTIONS. The AM-6879 contains the audio amplifier, squelch, and speaker circuits. It should be the first suspect for a no-audio problem. This could be confirmed by hooking the handset on the unused audio connector of the RT.

19. INDICATORS FOR TROUBLESHOOTING. When the radio is powered up, you should hear band switching. If not, change the frequency by 10 MHz (between 2 and 30 MHz), and key the PTT switch. If no band switching is heard, suspect the RT or PA (do the checks from paragraph 16 first). You should also hear a beeping noise from the speaker and handset-connected to J1 of the RT. If the beep is heard in the speaker and not the handset, suspect the handset, then the RT. If the beep is heard in the handset but not the speaker (checks in paragraph 16 were OK, SPEAKER switch in ON position, and squelch switch in OFF position), suspect the AM-6879. The yellow TUN lamp should light, but the other indicators on the AM-6545 should not. If they do, suspect the AM-6545. Pressing the LIGHT switch on the RT should light the lamp in the frequency windows, and pressing the FAN/LAMP TEST switch should light all six indicators and the fans should become audible in AM-6545 and CU-2064. If the indicators do not light or fans do not run, suspect the AM-6545 unless the only indicator that does not work is the fan in the CU-2064; then suspect CU-2064. Input voltage must be between 20 and 32 v DC. After 60 to 90 seconds, the RDY lamp should light. If not, try the warm-up again. If it still does not work, suspect the AM-6545.

20. TUNING. Press the PTT switch (momentarily).

- a. A steady tune signal should be heard.
- b. The RDY and TUN lamps should remain lighted until the XMT light comes on.
- c. The tuning motors in AM-6545 and CU-2064 should be audible.
- d. After 5 to 20 seconds, only the RDY lamp should remain lit, and the tune tone should disappear.

21. TRANSMIT. Press and hold the PTT switch.

- a. The speaker should be muted (no sound).
- b. The green XMT lamp should light.
- c. The high-voltage power supply in the AM-6545 should whine.
- d. The M1 meter should deflect, and sidetone should be heard when you blow into the handset.

NOTES: If the FIL lamp comes on, refer the AM-6545 to higher maintenance.

If the AM-6545 bandswitch rotates continually, remove power and replace the AM-6545.

If the equipment shuts down during operation, check for overvoltage (above 32 v DC), check CB1 and CB2 (overload), and check the louvers of the AM-6545 and CU-2064 for clogging (overheat).

The RT-1209 is the component most likely to fail. Therefore, it should be the component suspected first.

PRACTICE EXERCISES:

9. With the AN/GRC-193 turned on and the FAN/LAMP test button pushed, the FIL lamp does not light. You would--
 - a. change the filter.
 - b. change the lamp.
 - c. check the fuse.
 - d. evacuate the AM-6545.
10. In the W2 cable, from AM-6879 to AM-6545, pin U goes to pin--
 - a. L.
 - b. B.
 - c. 38.
 - d. 39.
11. What condition would cause a shutdown during operation?
 - a. an open pin V in the W2 cable
 - b. 20 v DC available from the battery
 - c. 34 v DC available from the battery
 - d. a shorted squelch switch
12. Pressing the PTT switch should cause which lamp to light?
 - a. PA
 - b. CPLR
 - c. TUN
 - d. XMT

//

ANSWERS:

- 9. d.
- 10. a.
- 11. c.
- 12. d.

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22. SUMMARY. You can system troubleshoot the AN/GRC-193A radio system to determine the component, cable, or audio device causing a malfunction. You know what you are responsible for replacing or repairing and how to prepare the components for a higher level of maintenance as required.

Lesson 4 PERFORM PREVENTIVE MAINTENANCE CHECKS AND SERVICES ON AN/GRC-193A

OBJECTIVE

Upon completion of this lesson, you will be able to perform PMCS on the AN/GRC-193A radio set.

REFERENCES

This lesson is based on TM 11-5820-924-13 and other materials approved for US Army instruction. However, development and progress render the text continually subject to change. Therefore, base your examination answers on material presented in this subcourse rather than on individual or unit experience.

24. INTRODUCTION. PMCS are done to--

- Spot small radio set problems and correct them before they cause serious trouble.
- Keep the radio equipment in good physical condition.
- Ensure that each component is functioning properly, both as an individual component and with other components of the radio set as installed.

Organizational-level PMCS for radio sets normally are done on a monthly and quarterly basis as scheduled on DD Form 314 (Preventive Maintenance Schedule and Record). Your supervisor establishes a monthly and quarterly PMCS schedule (DD Form 314) for each wheeled vehicle that has a radio set, but this PMCS may be done on a more frequent basis as directed by your supervisor. For example, monthly (M) PMCS might be scheduled for 12 January, 12 February, and 12 March; and quarterly (Q) PMCS (done every three months) might be scheduled for 12 January, 12 April, and 12 July. The organizational-level checks and services are listed in Table 7.

a. DA Form 2404. A record of any faults found during periodic PMCS and the corrective actions taken should be maintained on DA Form 2404.

b. DA Form 2407. A faulty item of equipment that cannot be repaired at the organizational maintenance level is sent to the next higher level of maintenance. It is accompanied by a DA Form 2407.

NOTE: Complete instructions for the use, completion, and disposition of maintenance forms and records are in DA Pam 738-750, The Army Maintenance Management System (TAMMS).

25. ORGANIZATIONAL-LEVEL PMCS. Organizational-level PMCS for communications-electronic equipment are done to ensure that your unit radio equipment is in top operating condition. A comprehensive PMCS program reduces equipment downtime and increases your unit operational readiness. Some PMCS are considered to be routine and should be done anytime you see that they

need to be done. For some items of equipment, routine PMCS are not listed in the PMCS table. Routine PMCS that are listed in the PMCS table are there because others have reported unusual or significant problems with a particular item of equipment. Some routine PMCS would include the following:

a. Check and ensure that the vehicle radio set, as installed, is complete. Refer to TM 11-5820-924-10-HR for end item listings that can be used to inventory the equipment.

CAUTION

USE ONLY CLEAR WATER AND A RAG TO CLEAN PLASTIC SURFACES. DO NOT PAINT PLASTIC SURFACE. DAMAGE TO PLASTIC WILL RESULT IF CLEANED WITH SOLVENT OR PAINTED.

b. Check equipment surfaces for corrosion, rust, and fungus. Clean and touch up paint as appropriate.

c. Check the controls of components to ensure that knobs are not missing, broken, or loose and that controls turn properly.

d. Check for loose plugs and jacks. Tighten cable plug lock rings and cable restraining devices (glands). If a plug has an O-ring, check and ensure that it is properly installed and lubricated. Tighten the component jack lock rings.

e. Check the plug-to-jack connections, and ensure the proper plug orientation and tightness of connections.

f. Check for loose mountings, hardware, brackets, and so on. Tighten as appropriate.



ENSURE THAT THE CORRECT TYPE OF BOLTS OR SCREWS, STAR WASHERS, AND NUTS ARE USED AND PROPERLY ASSEMBLED. SEVERE ELECTRICAL HAZARDS EXIST WHEN ITEMS OF EQUIPMENT ARE NOT PROPERLY INSTALLED AND GROUNDED.

g. Check for bent or missing mounting guides and connector pins. All unused jacks must have protective (dust) covers installed.

h. Check cables for fraying, cuts, cracks, dry rot, or other damage; and fix or replace as appropriate. Check for improperly routed cables. Refer to an appropriate TM 11-2300-series installation manual for cable routing instructions.

NOTE: Before doing the PMCS listed in Table 7, check and ensure that all current modification work orders (WOs) for the specific radio set have been accomplished. DA Pam 310-1, Consolidated Index of Army-Publications and Blank Forms (microfiche), paragraph 82, contains a listing of current MWOs for communications-electronics equipment.

- As a minimum, the O in the INTERVAL column indicates when a check and service should be done as follows: monthly (M) and quarterly (Q).
- The numbers in the ITEM NO column show the order in which the checks or services should be done. These numbers should be used when recording deficiencies and shortcomings on DA Form 2404.
- Perform routine preventive maintenance as required when inspecting each item.

Table 7. Organizational quarterly PMCS.

ITEM NO	ITEM TO BE INSPECTED	PROCEDURES
1	Receiver-transmitter VOLUME control knob	Check to see if RT VOLUME control knob is loose, missing, or damaged. If so, tighten or replace knob.
2	Receiver-transmitter SB (Sideband) control knob	Check to see if RT SB control knob is loose, missing, or damaged. If so, tighten or replace knob.
3	Receiver-transmitter MODE control knob	Check to see if RT MODE control knob is loose, missing, or damaged. If so, tighten or replace knob.
4	Amplifier-converter TTY ON/OFF/SPKR ON control knob	Check to see if AMPL-CNVTR TTY/SPKR control knob is loose, missing, or damaged. If so, tighten or replace knob.
5	Amplifier-converter LOOP CURRENT SELECT control knob	Check to see if AMPL-CNVTR LOOP CURRENT SELECT control knob is loose, missing, or damaged. If so, tighten or replace knob.
6	Power amplifier CB1 rubber boot	Check to see if PA CB1 seal boot is torn, cracked, split, or missing. If so, notify a higher maintenance authority.
7	Power amplifier CB2 rubber boot	Check to see if PA CB2 seal boot is torn, cracked, split, or missing. If so, notify a higher maintenance authority.
8	Power amplifier S1 FAN/LAMP TEST switch	Check to see if PA S1 FAN/LAMP TEST seal boot is torn, cracked, split, or missing. If so notify a higher maintenance authority.
9	Power amplifier M1 meter glass	Check to see if PA M1 meter glass is cracked or missing. If so, notify a higher maintenance authority.

PRACTICE EXERCISES:

13. PMCS for AN/GRC-193A should be scheduled how often?
- a. monthly
 - b. quarterly
 - c. weekly
 - d. semiannually
14. Organizational maintenance PMCS normally is done--
- a. only when scheduled on DD Form 314.
 - b. when scheduled on DD Form 314 or as directed by your supervisor
 - c. when the operator reports a trouble on DA Form 2404.
 - d. when required by the radio set logbook.
15. A record of all faults found during PMCS will be listed on--
- a. DA Form 2404.
 - b. DA Form 2407.
 - c. DA Form 2402.
 - d. DA Form 2408-5.
16. Plug orientation is an example of--
- a. scheduled PMCS.
 - b. routine PMCS.
 - c. annual PMCS.
 - d. an operational check.

////////////////////////////////////

ANSWERS:

13. b.
14. b.
15. a.
16. b.

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26. SUMMARY. You can perform PMCS that keep the system in good operating condition. This skill along with what you have learned about installing, operating, and troubleshooting the system allows you to maintain the system at an organizational level.